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Configuration Management of the L96 and L97 Grenades

Final Technical Report
by

Philip E Quantick

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P.E.Quantick

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1. Abstract

1.1 The L96 and L97 anti-riot grenades were developed and tested by DERA Porton Down, in a joint UK/US collaborative programme. The grenades are now in-service with US Army and UK MOD. Follow-on contracts were placed with DERA by the US and UK authorities for the provision of Design Authority activities and to develop a new electrical clip assembly for the grenades.

1.2 The Design Authority activities have involved configuration management of the Technical Data Pack, including the incorporation of a number of minor drawing amendments. DERA has also facilitated the procurement of grenades for US qualification testing.

1.3 The electrical contact clip currently used on the grenades has been redesigned to provide improved sealing against moisture ingress; facilitate ease of manufacture and to retain its integrity when functioned.

1.4 A process study together with tool design and manufacture has been conducted in collaboration with a UK company. The tooling has been used to produce first-off samples for evaluation by DERA and US DoD.

1.5 The new clip assembly has been successfully tested in the L97 and US M76 grenades.

1.6 To ease assembly a new electrical fuse-head assembly has also been designed.

1.7 Further work is now required to incorporate some tooling modifications to ease manufacture of the clip and fuse-head assemblies prior to the manufacture of items for acceptance testing.

2. List of Keywords

L96/L97/anti-riot/M76/grenades/design authority/electrical contact clip/fuse-head

3. Contents

4. List of Appendixes

Appendix A	Photograph of existing in-service electrical contact clip assembly.
Appendix B	Photograph of new electrical contact clip assembly.
Appendix C	Photograph showing breakage of contact clip retaining ring.
Appendix D	Proposed design of connector for Type N32B electrical fuse-head.
Appendix E	Cost estimate for contact clip assembly tooling modifications.
Appendix F	Cost estimate for connector for Type N32B fuse-head.

5. Design Authority Activities

5.1 The US DoD and UK MOD jointly own the Technical Data Pack (TDP) for the L96 and L97 grenades. The TDP has been maintained and updated, by DERA, under the auspices of this contract and a similar contract from UK MOD.

5.2 L97 grenades from the first UK production contract were subjected to critical examination to investigate a number of minor design changes, incorporated by the manufacturer after consultation with MOD and DERA to ease production. A Configuration Management Meeting was held in the US to discuss the merits of the various changes and to formally approve incorporation into the TDP.

5.3 DERA has acted as a focus for liaison activities between US DoD (APG) and the UK contractor providing grenades for US assessment and pre-contract qualification testing.

5.4 The proof results for all L96 and L97 grenades manufactured by the contractor are provided and monitored by DERA to check for trends in performance.

6. Development of Electrical Contact Clip

6.1 During the acceptance testing of the L97 grenades it was noted that a number of problems were associated with the electrical contact clip. This included failure to function due to lack of electrical continuity, ingress of water during immersion testing and a high incidence of breakage when functioned at elevated temperature. The latter feature caused a safety concern as the metal contact clips were projected from the grenades.

6.2 The current clip assembly is shown at Appendix A. The unit consists of a number of small components that are difficult to assemble, with a consequential cost penalty. Attachment of the fuse-head to the clip assembly is either by mechanical crimping or soldering. It is essential to ensure that assembly is fully sealed against moisture ingress but due to the design of the unit and the difficulty in assembly, this is extremely difficult to achieve, without the application of an external sealant.

6.3 A feasibility study was undertaken to identify alternative designs for the clip assembly that would alleviate the above problems and reduce the cost of the item and assembly costs. A further point to note is that the design rights to the existing clip are owned by a UK company who are entitled to royalty payments from US DoD. This clip and its derivatives are used on all US 66mm grenades. From this perspective there are again cost savings to be made from the introduction of a new clip.

6.4 A detailed study was undertaken with a UK plastic-moulding company, to investigate the best options for clip designs that could be incorporated into a one-piece unit produced by injection moulding. A parallel programme was initiated with Davey Bickford of France, who produce the electrical fuse-head used in the grenades, with the aim of obviating the need for crimping or soldering of the fuse-head to the clip assembly.

6.5 A number of design schemes for the clip assembly were proposed and investigated using 3-D computer modelling to examine the feasibility of manufacture in production quantities. A preferred option was down-selected and tooling for spring clips and clip assembly manufacture was procured.

6.6 The new clip assembly is shown at Appendix B. In order to meet an urgent requirement from APG 100 clip assemblies from the first pre-production run were provided for testing in the US. The clip assemblies were fitted to inert M76 grenades and incorporated into a previously scheduled test programme of grenade launchers.

6.7 Prior to shipment of the clip assemblies to the US it was possible to conduct a small number of test firings of the new clip assembly fitted to the L97 grenade. It was found that due to the superior gas seal achieved with the new clip assembly the propulsion charge in the grenades needed to be reduced, to prevent breakage of the plastic ring that retains the clip assembly in the grenade and expulsion of the clip assembly from the grenade. Subsequent testing has shown that correct range and height to burst of the grenade can be achieved with a reduced propulsion charge at ambient temperature (+20°C) and low temperature (-33°C), without breakage of the retaining ring. However, due to the increased energy of the propulsion charge at elevated temperature (+71°C) it was not possible to ensure correct functioning characteristics without breakage of the retaining ring. (See photograph Appendix C).

6.8 Testing has been conducted to investigate how the configuration of the 'blow-out' hole, from which the propulsion gases are vented, effects the integrity of the retaining ring. It has been shown that weakening this hole enables the grenades to meet the performance requirement without breakage of the retaining ring. Further investigation into this feature is required and modification to the clip assembly tooling will be necessary.

6.9 As mentioned in 6.6 above the new clip assembly has been tested in the US on inert M76 grenades. The test firings were extremely successful and a report is awaited. The propulsion charge used in the test was the standard for this grenade. No breakage of the retaining ring was experienced at any temperature. This test, using M76 grenades, has subsequently replicated by DERA with similar results. From examination of the grenades after firing it is considered extremely likely that the propulsion gases escaped into the body of the grenades which presumably would not be possible or acceptable in live grenades. Again further investigation is recommended.

6.10 It should be noted that the dimensions of the propellant cavity in the M76 grenade are different to that of the L96/97 grenades. It may be necessary to modify the design of the fuse-head connector end of the clip assembly to facilitate fitment in the M76 grenade.

6.11 During the production of the clip assemblies for the above preliminary testing it has become apparent that the incorporation of some fairly minor design changes would have a very beneficial effect on the manufacturing process. This would result in an improved moulding process, reduced wastage and lower unit cost. A new method of connecting the electrical fuse-head to the contact clip has also been designed. (See Appendix D) In order to accommodate this feature the contacts on the clip assembly will need to be in a parallel alignment and this will necessitate a modification to the spring clips and mould tooling.

7. Conclusions

7.1 The transition of the L96 and L97 grenades from development status to service stores has been successfully achieved, supported by the Design Authority activities funded by this contract.

7.2 The technical objectives with regard to the new electrical clip assembly stated in the proposal dated 27 Sep 99 (DERA/CBD/BSC/SS/L9697DA/BID Issue 2.0) have been met or exceeded.

7.3 The new clip assembly is likely to result in reduction in unit cost due to fewer component parts and assembly time.

7.4 The new clip assembly will provide greatly improved resistance to moisture ingress without the need for additional sealant.

7.5 The testing conducted to date indicates that the new clip assembly will reduce the incidence of the clip assembly being ejected from the grenade on functioning. This feature is particularly prevalent at elevated temperatures and causes concern from a safety viewpoint..

7.6 The tooling for the contact clip is suitable for production quantities, rather that purely for developmental purposes as originally anticipated. Some minor modifications to the tooling are required to further enhance the manufacturing process and to realign the connectors at the fuse-head end. Cost details are included in Appendix E.

7.7 A new method of connecting the electrical fuse-head to the contact clip has been devised in conjunction with Davey Bickford. This will obviate the need for soldering or crimping. Further funding will be required to provide production standard samples for acceptance testing. Cost details are included at Appendix F.

7.8 The new clip assembly should be suitable for use with the M76 grenade. Slight modification to the current version, designed for the L96/97 grenades may be necessary.

8. Recommendations

8.1 Tooling for the new electrical clip assembly should be modified to improve the manufacturing process.

8.2 Development of the electrical fuse-head connector should be completed to enable the procurement of samples for acceptance testing.

8.3 Further testing should be conducted with a view to accepting the new electrical clip into service.

8.4 The position regarding future US/UK collaboration on this project should be clarified.

9. Glossary

L96	Grenade Discharger Anti-Riot Irritant L96A1
L97	Grenade Discharger Anti-Riot Practice L97A1
APG	Aberdeen Prooving Ground

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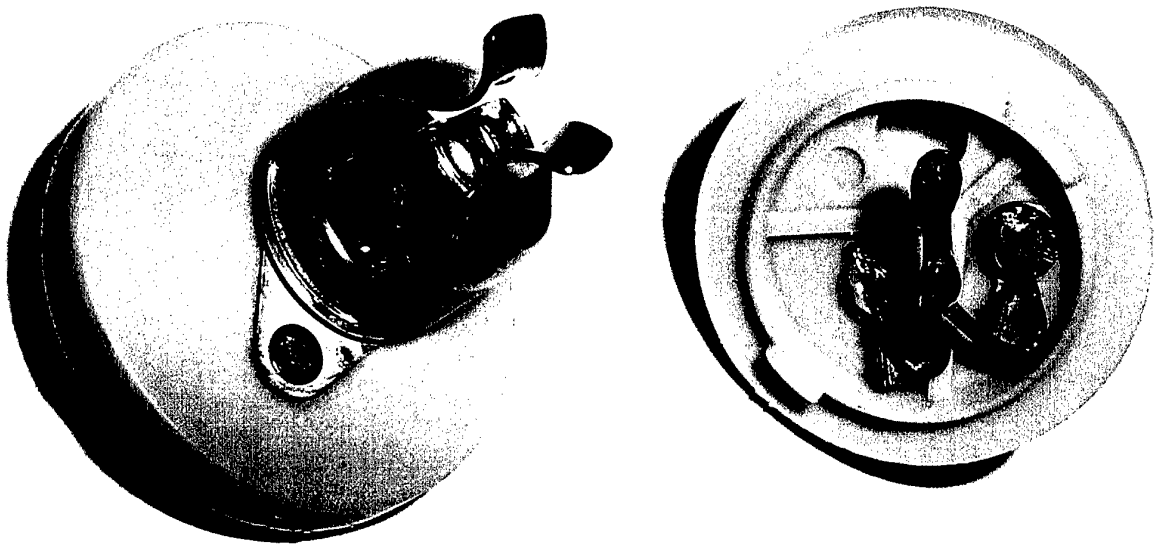
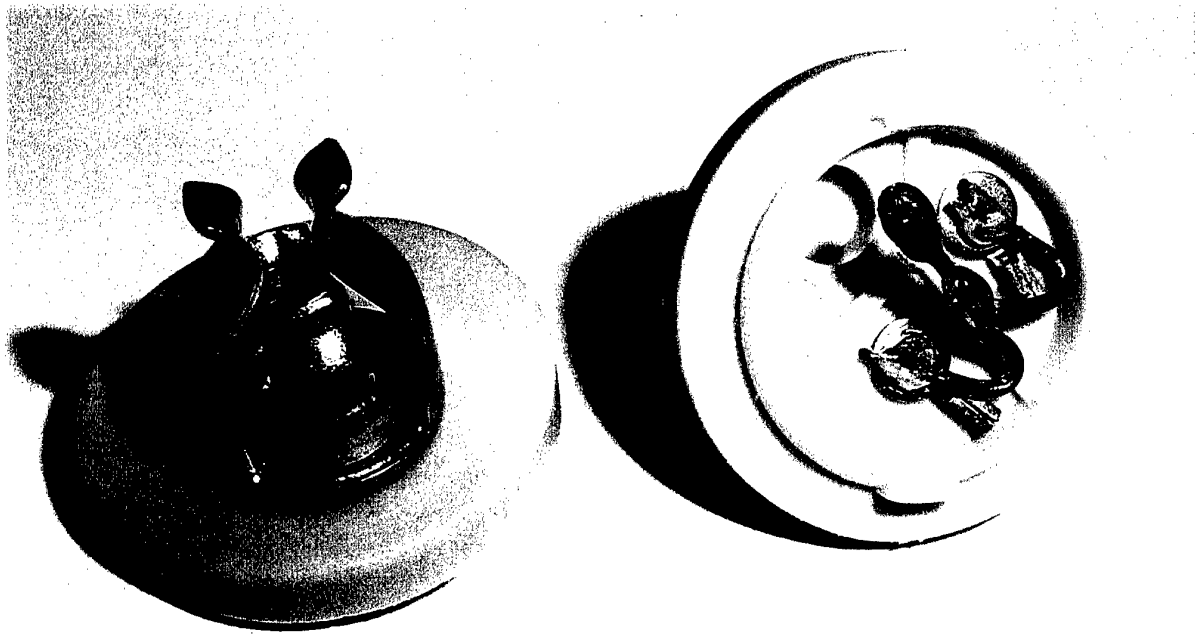
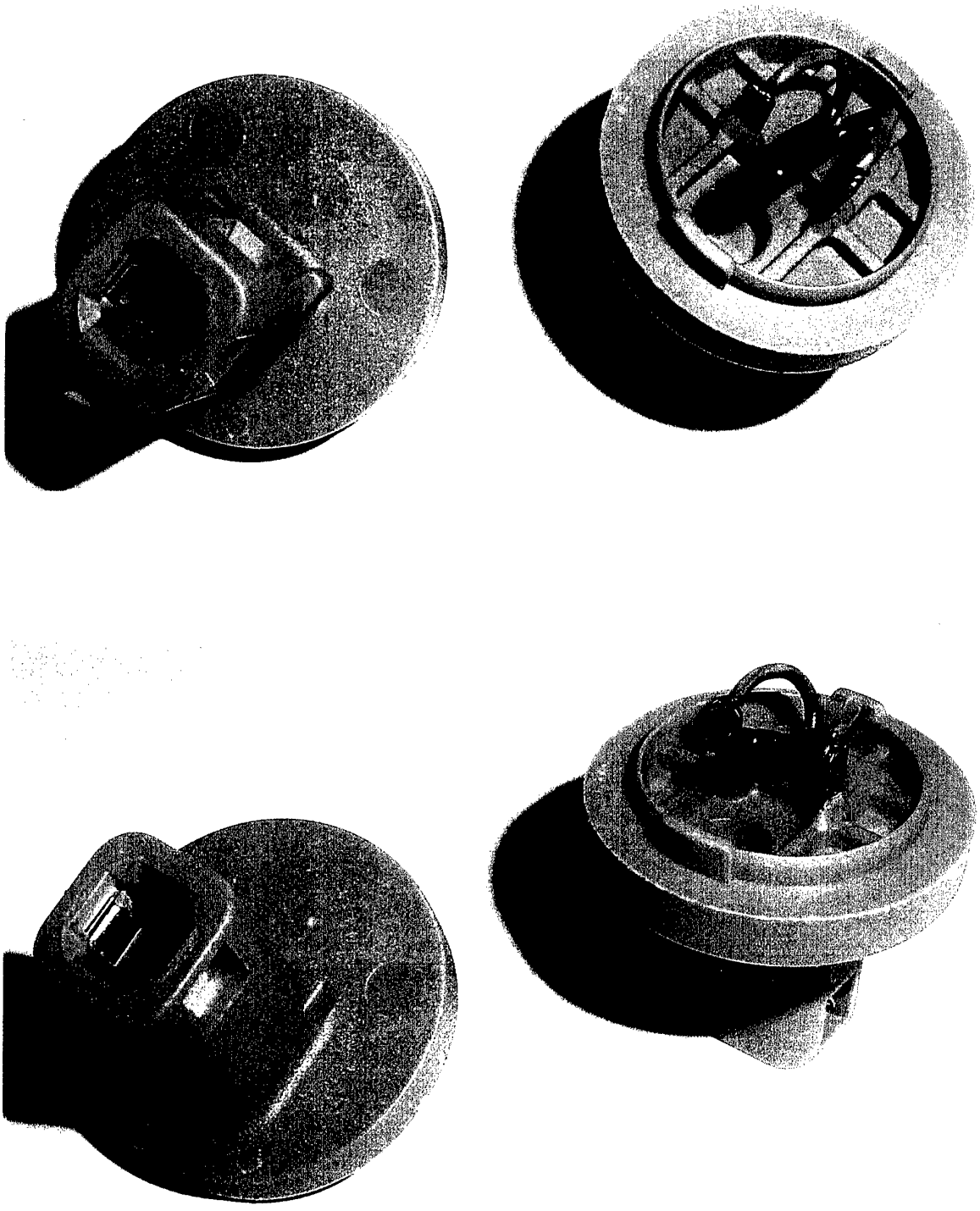
APPENDIX A





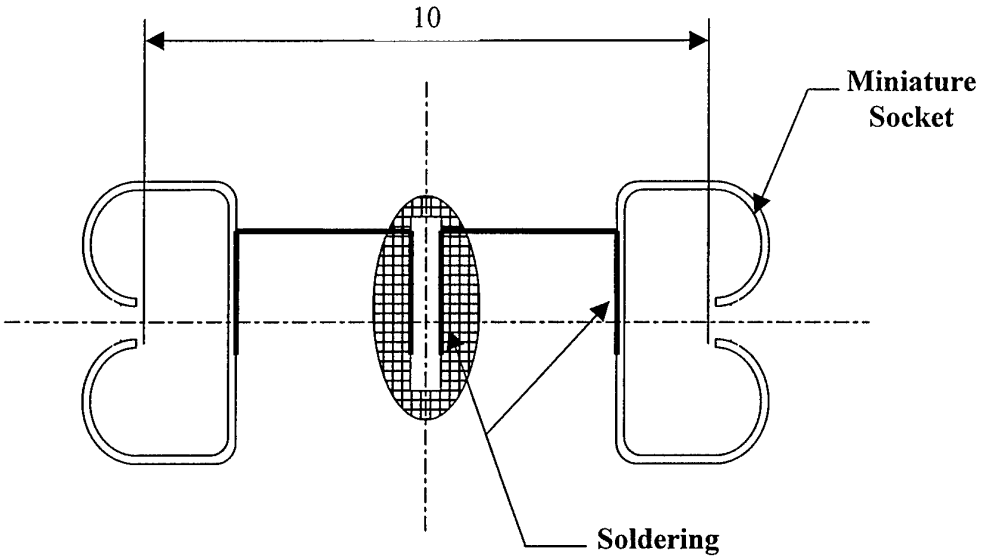
APPENDIX B

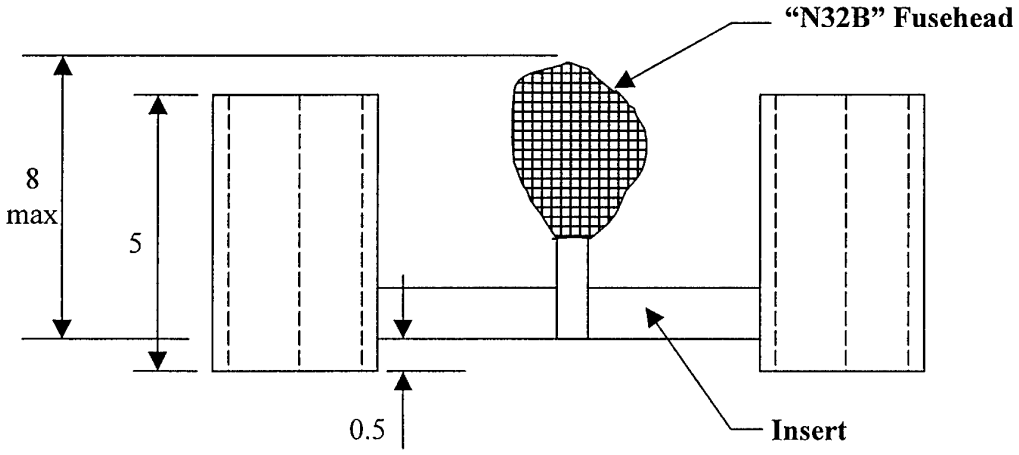


APPENDIX C

APPENDIX D

Proposed Design of Connector for Type N32B Electrical Fuse-Head





Annex E

Proposed modifications to tooling

Changes to the existing 3D CAD model to modify Spade Connector Layout, alter material thickness of friction contacts and improve tool location features for springs. Cost $2600.

Modifications to spring development tooling. Cost $550.

Modifications to the existing injection mould tool to facilitate the component design changes. Cost $3430.

Injection mould tooling trial. Cost $260.

Time-scale for the above is approximately 10 weeks.

Annex F

Development of proposed new connector for Type N32B electrical fuse-head.

Complete design and produce documentation. Cost $1000.

Produce tooling. $880.

Produce prototypes (up to 1000 units). Cost £6.85 each.

Note that the cost of production quantities (7,000 to 10,000 units) would be $2.20 each.

Time-scale for the above is approximately 16 weeks.